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Running Head: Focused Attention and Recovery of Initial Learning

A Focused Attention Intervention for Preventing the Recovery of Initial Learning

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Abstract

Psychotherapy introduces new learning that can retroactively interfere with the expression of initial learning that contributed to psychological dysfunction. However, expression of the initial learning can spontaneously recover with time, and the prevention of this recurrence remains elusive. In a laboratory study, we explored whether having participants focus their attention on the present moment through guided instruction would reduce the recurrence of initial learning with the passage of time. All participants first learned a particular response to a cue before learning a new response. During testing, participants were presented with the cue and asked to provide a response. When tested immediately, participants provided the most recently learned response, but after a 16 min delay they also provided the initially learned response (i.e., spontaneous recovery). The focused-attention intervention significantly reduced the spontaneous recovery of the initial learning. This finding has theoretical value for research on therapeutic intervention.

Keywords: retroactive interference; spontaneous recovery; focused attention.

Introduction

The treatment of psychological problems is often initially successful at reducing dysfunction. However, the hard-won positive changes are fragile and patients commonly relapse (i.e., re-experience their symptoms following treatment). This unfortunate consequence can be detrimental and its prevention is therefore a goal for any psychotherapy. Accordingly, researchers have studied mechanisms responsible for relapse in clinical and laboratory settings. Several highly reproducible learning phenomena are taken as laboratory examples of relapse (e.g., Bouton & Swartzentruber, 1991) and have been used to better understand both its underlying processes, and the ways to reduce its likelihood.

Learning theory views the behavior changes that result from therapy, and many examples of relapse, as interference effects or conflicts caused by competing memories. Therapy introduces new learning that retroactively interferes with the expression of the initial learning that was responsible for the psychological dysfunction. In the laboratory, this retroactive interference can be observed in rats, for example, when they learn that a tone is no longer followed by a fearful shock (i.e., extinction), and this new learning reduces the ability of the tone to elicit fear. Similarly, when humans learn that a particular medicine (cue) is paired with nausea (outcome) in a computerized task, and later learn that the medicine is no longer paired with nausea (e.g., Alvarado, Jara, Vila, & Rosas, 2006), the latter expectation retroactively interferes with the former.

Though this type of human predictive learning task is not aversive physically it is believed to activate the same neurobiological substrates as those found to be hyperactive in real-life situations of aversion (Phelps, 2006). Participants told that one neutral cue predicts an aversive stimulus and another predicts a stimulus associated with safety show greater amygdala activation as measured by functional magnetic resonance imaging (fMRI) when presented with the aversively conditioned cue (Phelps et al., 2001). This neural correlate represents a biological process that underscores verbal conditioning experiments (Cook & Harris, 1937).

According to learning theory, a relapse can occur, to varying degrees, from contextual change (e.g., Bouton, 2000). Specifically, once a cue becomes associated with an outcome, subsequent modification of this association will be context dependent (see Bouton, 1993, for review), especially when that modification interferes with the behavior controlled by the earlier association (Nelson & Callejas-Aguilera, 2007; see also Nelson, 2009). Thus, when the cue is presented outside the context where this later learning occurred, the new learning will not be retrieved and the initial learning will be expressed free from the interference produced by the later learning. A rat that first learned that a tone predicted shock and then later learned that it was associated with food will again show fear when tested outside of the Skinner Box (i.e., context) where the tone was paired with food. This change of context will result in a failure to recall the association learned in the second phase which allows for the fearful expectation to reemerge (e.g., Peck & Bouton, 1990). Though this example highlights the effects of physical context change, it is important to note that one of the most common changes in context is the passage of time. The rat that extinguished his expectation of shock will spontaneously recover his fear following a temporal delay. This spontaneous recovery of initial learning that occurs with time is a well-known phenomenon (e.g., Pavlov, 1927) that is employed in laboratory analogues of relapse.

The significance of contextual control and information interference for clinical psychology has been acknowledged for over 25 years (e.g., Bouton, 1988), and has been used to explain some forms of psychopathological relapse. For example, it argues that the relapse of initial maladaptive learning is due to a contextual change between the therapeutic setting and daily life which causes a failure to retrieve the new responses learned in therapy. The ideas are relevant to diverse phenomena from basic learning to Emotional Intelligence (Nelson & Bouton, 2002).

The efforts that have been made in the laboratory to reduce the recovery of initial learning have met with mitigated success (see Glautier, Elgueta, & Nelson, 2013, for a brief review). Most have tried to induce the generalization of new learning by manipulating specific stimulus relationships within the retroactive interference context, like introducing retrieval cues (e.g., Brooks & Bouton, 1993), increasing the amount of retroactive interference training (e.g., Denniston, Chang, & Miller, 2003; but see Bouton & Swartzentruber, 1989), or increasing the number of contexts in which the new contingency is learned (e.g., Glautier & Elgueta, 2009, but see Bouton, Garcia-Gutierrez, Ziliski, & Moody, 2006). These mixed results call for a more efficacious intervention.

Research suggests that focusing attention on the here-and-now (e.g., mindful breathing exercises) may be effective for priming the retrieval of recent memories because it generates greater attention to stimuli in the current environment (Bishop, et al., 2004; Eberth & Sedlmeier, 2012; Hölzel, et al., 2011; Kabat-Zinn, 2003). The goal of the present study was to test the hypothesis that a focused-attention induction could prevent the recovery of first-learned information. We chose a task developed by Alvarado et al. (2006) to measure retroactive interference and spontaneous recovery. In Phase 1, participants learned that a medicine was associated with nausea, but not fever (or the opposite, counterbalanced), whereas in Phase 2 the contingencies were reversed. Learning in Phase 2 was expected to interfere with that learned in Phase 1 for participants tested immediately after Phase 2. However, a temporal context-change caused by a short retention interval (see Bouton, 1993, 2000) interposed between Phase 2 and the Test Phase was expected to reduce this interference and promote recovery of initial learning, an aforementioned mechanism responsible for relapse (i.e., recurrence of symptoms). However, we hypothesized that requiring participants to follow a focused-attention intervention during the retention interval would enhance the generalization of the interfering learning episode and reduce the recovery of initial learning.

The instructions we selected for our study were derived from mindfulness training and directed participants to focus on their breathing. Our manipulation models the effect of first-time mindfulness instructions. The similarity is especially evident considering that the simplest definition of mindfulness is focused attention to the present moment in an open, curious, and non-judgmental manner (Kabat-Zinn, 1990, 1994). It is well recognized in the mindfulness literature that bringing attention to the breath is an effective method for subsequently increasing awareness and focusing the mind on the here-and-now. The protective effect of a mindful-breathing exercise on learning-order effects has been observed for extinction and behavioral resurgence (McHugh, Procter, Herzog, Schock, & Reed, 2012). The effects of physical or temporal contextual manipulations have not yet been assessed despite that these are critical variables involved in the laboratory study of relapse. The present research begins to address this gap in the literature by focusing on the potential benefits of a mindful-breathing exercise on recovery from retroactive interference with the passage of time, a good analogue of some types of relapse in real-life situations (Bouton, 1993, 2000).

The focused-attention intervention was expected to attenuate the recovery of initial learning following a delay by enabling participants to focus their attention on the here-and-now (i.e., remain in the present) and thus to decrease the conflict between competing memories by favoring the most recently learned associations. Specifically, the focused attention intervention was expected to produce greater sensitivity to the current contingencies (i.e., Phase 2 contingencies) and to reduce behavioral control exerted by previously learned contingencies (i.e., Phase 1 contingencies) more than a control intervention that instructed participants to let their minds wander (i.e., unfocused attention that people normally have in the absence of instruction), during the retention interval between training and testing.

Method

Participants and Design

Forty-eight undergraduate students participated in the present study (32 females and 16 males, M_{age}=20.54 yrs; *SD*=2.05). A 3 (*Group: Focused Attention, Unfocused Attention, Immediate Testing*) x 2 (*Outcome: O1, O2*) x 2 (*Phase: Phase 1, Phase 2*) mixed factorial design was employed. The participants were randomly assigned to one of the three groups with the constraint that the groups were balanced as closely as possible in proportion of each sex (*ns*= 16). Prior research has detected effects of a focused attention intervention with sample sizes of 30 (McHugh et al., 2012) and the recovery effects of interest using the methods employed here have been captured with sample sizes of 20 (i.e., Alvarado et al., 2006). To the extent that the focused-attention manipulation produces a robust effect, one of practical use, it should be detectable.

Apparatus

The experiment took place in a 4 x 8 - m room. Participants performed the experiment on a Dell Latitude E540 computer. The procedure was programmed with Affect 4.0 (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010). The task involved the presentation of a fictitious medicine “X” called “Batim,” which either caused fever or nausea which were counterbalanced as outcomes 1 and 2 (O1, O2) between participants. These stimuli were presented on black screens in white font. At the top of the screen, the words “Hospital San Louis” were present.

Causal Learning Task

The general characteristics and parameters of the causal learning task used in the present experiment were adapted from Alvarado et al. (2006). The task consisted of a causal learning scenario where participants learned that fictitious drugs were associated with different illnesses

Every participant underwent two phases of training before testing. At the start of Phase 1, a screen informed participants of the general features of the task. The following instructions were presented (in French):

> It has been detected in the city of Guadalajara that some patients presented certain side effects after ingesting a specific medicine. You will be seeing some patient files. Your

> work will be to indicate if the medicine produces the side effect by clicking on the appropriate response button on the screen; once you have made your choice, you will observe the side effect experienced by the patient. This information will allow you to learn the relationship between the medicine and the side effects. Your response will be random at the beginning, but soon you will become an expert. If at any point you detect some changes in the experiment please continue, because they are part of the experiment. Finally, remember that you can take all the time you need. When you are ready to begin, please click below to start.

In Phase 1, all groups received 15 predictive trials where the sentence “This patient ingested Batim, this medicine produced…” was displayed immediately below the name of the hospital in the center of the screen. Below that sentence the side effects “fever” and “nausea” were presented on two separate buttons (the right/left positions of the two responses were counterbalanced across trials). Once the participant clicked one of the buttons, the stimuli disappeared from the screen and a feedback message was presented at the center of the screen for 3-sec, it was either the sentence “Batim produced fever” or “Batim produced nausea” (counterbalanced).

In Phase 2, the procedure was identical to that described in Phase 1, except that during the 15 trials, X was paired with O2. If Batim had been predictive of fever in the previous phase, it was now predictive of nausea, for example. The number of trials in each phase was reduced from what was used by Alvarado et al. (2006) as their data showed that participants quickly learned the contingencies.

In both phases, probe trials were presented every 5th trial. A screen was displayed with the following instruction: “Please guess the degree to which taking Batim causes each of the following side effects by using a scale from 0 to 9, where 0 means that

Batim never causes the effect and 9 means that Batim always causes the effect." Below this instruction, both side effects were displayed on the left part of the screen (the up/down positions of the two responses were counterbalanced across trials). To the right of each side effect, a 9-point scale, ranging from 0 (It never caused the side effect) to 9 (It always caused the side effect) was presented. Participants made their choice with a click on the scale using the left mouse button.

Immediately after Phase 2 training, the Immediate Testing group was given a final test trial, while both Focused Attention and Unfocused Attention groups were instructed to listen to one of the two inductions described below. The Focused Attention group received the final test trial after completing a breathing exercise for 13-min and answering five questions about the exercise (manipulation checks that took approximately 3-min), whereas the Unfocused Attention group was tested after a 13-min control exercise and answering the five manipulation-check questions.

Inductions

The Focused Attention induction (recorded instructions translated from McHugh et al., 2012) instructed participants to focus on the actual sensations of breath entering and leaving the body. Participants were told that there was no need to think about the breath–just to experience the sensations of it; and when they noticed that their awareness was no longer on the breath, to gently bring their awareness back to the sensations of breathing (see Appendix 1). We expected to observe a protection from relapse in the Focused Attention group since the verbal instructions to focus on the here-and-now should produce greater sensitivity to the most recent operative contingencies (i.e., Phase 2 contingencies) and thus continue to interfere with the behavioral control exerted by previous learning (i.e., Phase 1 contingencies).

In the Unfocused Attention induction, participants were told to let their minds take them wherever they went as they normally would throughout the day, and to think about whatever came to mind (also translated from McHugh et al., 2012; see Appendix 2). This instruction is considered similar to people's natural state and constitutes an appropriate control group (Kabat-Zinn, 1990, 1994). It is worth noting that when naïve participants follow such instructions they do not activate neural structures involved in attention like they do when following instructions to focus their attention (Dickenson, Berkman, Arch, & Lieberman, 2013). This induction controlled for the general effects of verbal instructions during the interval between Phase 2 learning and testing. Moreover, it resembled the control group used in Alvarado et al.'s paradigm where participants were left alone in the experimental room during the retention interval where their minds could wander freely. We expected to observe a relapse in the Unfocused Attention group since the verbal instructions should have no particular effect.

Variants of these instructions for both inductions were repeated every 30-60s for 13-min. After the induction, participants reported the extent to which they agreed or disagreed with the following statement: "I was able to follow the instructions" on a 4-point scale, with 1 = Disagree Strongly, 2 = Disagree, 3 = Agree, and 4 = Agree Strongly.

Results

Inductions

We examined participants' reports of their ability to follow the induction instructions as a manipulation check for its successful employment. In both conditions, participants reported relative ease with following the instructions, with no differences between conditions (*Ms* = 3.5).

Causal Learning Task

Random assignment distributed the female and male participants roughly equally between the groups. There were 11 females and 5 males in each of the Focused and Immediate Testing groups, and 10 females and 6 males in the Unfocused group. Gender was independent of the conditions, X^2 (2) =.19, p = .91.

The data were analyzed with mixed factorial analysis of variance (ANOVA). Outliers[1] were retained to keep the samples as representative as possible of the populations from which they were drawn. Analysis with or without the outliers supported the same conclusions. Simple effects were conducted with ANOVA using error terms appropriately derived from the overall ANOVA. Heterogeneity of variance between groups was assessed with Levene's test, and in the one case where it was observed

[1] Causal ratings for O1 and O2 each contained one outlier (i.e., 2 standard deviations or more away from the mean) in each group in Phase 1. On test, there was one outlier in Group Unfocused in the ratings of O2. Among the variables containing outliers, the outliers were skewed in a direction opposite to the mean of the group containing it. When average ratings were high (e.g., O1 ratings in Phase 1) outliers were low scores (e.g., 0, 2) and when average ratings were low, outliers were high scores (e.g., 9). Thus, there was no transformation of the data that could uniformly correct the skew without being confounded with the identity of the variable. Overall, no participant produced consistently extreme scores. Outliers increase error variance and decrease differences between outcome means, making any conclusions regarding significant differences between outcomes conservative. Rather than exercise the many degrees of freedom available to the researcher in treating these few scores the outliers were retained and the data remained unmodified.

(test ratings for O1), error variance was calculated assuming unequal variances and degrees of freedom were appropriately reduced by the Welch (1938) and Satterthwaite (1946) procedures. Effect sizes for the overall ANOVA are reported as partial eta-squared, and Cohen's *d* is reported for simple effects.

Causal ratings for O1 and O2 at the end of each phase and on test are shown in Figure 1. Each group is represented by a different symbol (see the legend and figure caption). The bottom-most labels of the X axis indicate the phase from which the ratings were obtained, and the outcome with which X was paired in that phase (e.g., "Phase 1 (X-O1)"). The labels directly under the X axis (i.e., "O1", "O2") indicate whether the ratings indicated by the points were for O1 or O2.

Phases 1 and 2

In Phase 1 X was paired with O1, and ratings for O1 were expected to be higher than for O2. In Phase 2 X was paired with O2, and O1 ratings were thus expected to be lower than O2. These data were analyzed with an Outcome x Phase x Group ANOVA. As just described, the difference between the outcome ratings was expected to depend on the phase which would be captured as a Phase x Outcome interaction. The Phase x Outcome interaction was reliable, $F(1,45) = 131.7$, $p < .0001$, $\eta^2_p = .75$. Simple-effect tests confirmed that ratings for O1 were significantly higher than those of O2 in Phase 1, $F(1,66) = 175.01$, $p < .0001$, $d = 3.05$, and that pattern reversed in Phase 2, $F(1,66) = 54.04$, $p < .0001$, $d = 1.44$. These results evidence that the participants learned the contingencies correctly.

Testing phase

Test data are shown in Figure 1 above the label “Test”, with ratings for O1 and O2 above their respective X-axis labels. At testing there was an expected spontaneous recovery of ratings for O1 in the Unfocused Attention Group, while the pattern of ratings in the Immediate and Focused Attention Groups remained the same as what was observed in Phase 2 (i.e., the predictive ratings for O2 were high whereas they were low for O1). These are the results of main interest because the focused attention was expected to enable participants to focus their attention on the here-and-now (i.e., remain in the present) and thus to decrease the conflict between competing memories by favoring the most recent one (i.e., X was followed by O2 but not O1 during Phase 2). Thus, the groups differed in their response to O1, but not to O2, which would be reflected as a Group x Outcome interaction. A Group x Outcome ANOVA of the test data revealed the expected interaction, $F(2,45) = 4.65$, $p = .01$, $\eta^2_p = .17$, as well as the less relevant main effect of Outcome, $F(1,45) = 14.29$, $p = .0005$, $\eta^2_p = .24$. There was no main effect of Group, $F(2,45) = 1.93$, $p = .16$.

Importantly, within-subject simple-effect tests showed a pattern consistent with Phase 2 where ratings of O1 were less than O2 in the Focused Attention, $F(1,45) = 10.42$, $p = .002$, $d = 1.2$, and Immediate Testing groups, $F(1,45) = 12.91$, $p < .001$, $d = 1.29$, but not in Group Unfocused, $F = .07$, $p = .79$. Between subjects, ratings for O1 in Group Focused and Immediate did not differ, $F(1,89) = .09$, $p = .75$. Ratings for O1 in Group Unfocused were greater than those in both Group Focused, $F(1,89) = 8.39$, $p = .005$, $d = .92$, and Group Immediate, $F(1,89) = 10.25$, $p = .002$, $d = .99$. There were no group differences among the ratings for O2, all F’s < 1, ps $\geq .41$.

Discussion

In the current study we observed that a focused-attention intervention favored the expression of second-learned information by reducing the reemergence of first-learned information following a delay (i.e., preventing spontaneous recovery). The mechanism through which this intervention reduced recovery from retroactive interference can be explained using the model developed by Bouton (1993). First, learning in Phase 2 consisted of both X➔O2 and X➔No O1 associations. As the inhibitory X➔No O1 association interfered with the initially learned excitatory X➔O1 association, it became temporally context-specific. Thus, after a contextual time change (delay), there was a failure to retrieve X➔No O1. This allowed for X➔O1 to be expressed in the Unfocused Attention group despite that this group showed strong X➔O2 and weak X➔O1 responding during Phase 2. The Focused Attention group responded differently because the intervention served to release the No O1 expectancy from contextual dependency, preventing the loss of inhibitory control.

An alternative to a context-change account of our results is one based on recency effects which are sensitive to delays. Normally, recency only facilitates the recall of Phase 2 learning when participants are tested immediately (i.e., recently) after the second learning phase, but, the focused attention intervention may have strengthened the most recent memories causing them to fade less quickly (Lustig, Konkel, & Jacoby, 2004). The mechanism for such an effect could have involved the differential activation of attentional resources (and the respective regions of the brain associated with attention). As mentioned earlier, research using fMRI has shown greater activation of an attentional network consisting of parietal and prefrontal structures during a focused attention induction than during an unfocused mindwandering induction (Dickenson et al., 2012). Thus, the recent No O1 expectancy may have been less susceptible to fading in our Focused Attention group perhaps because the manipulation engaged an attentional network.

Regardless of the mechanism, the results of the current study suggest that a focused attention intervention could serve as a temporal 'bridge' and facilitate the generalization of newly learned associations over time. According to Craske et al. (2008) it is through such an action that mindfulness-based interventions could improve the efficacy of psychological treatments that depend on the generalization of inhibitory learning (e.g., exposure therapy). This possibility, of course, remains hypothetical. The current study only demonstrated such an effect in healthy young college students trained to make predictive judgments within a short time frame in a laboratory setting. The use of college students in our study may have been favorable because the primary manipulation of interest involved the ability to follow directions, remain self-aware, and maintain control over one's thoughts. Students are typically good at all of these skills. As reported by Hölzel et al. (2011), individuals differ in the extent to which they are attracted to the practice of exercises based on focused attention. A natural question for future research is whether a brief induction would have the same effects on inpatients and outpatients, or on older participants.

The relatively small size of the sample could be of concern regarding the generalizability of the findings. Nevertheless, there are two points which moderate that concern. The recovery observed in Group Unfocused is consistent with that observed in a sample with vastly different cultural demographics using similar methods (Alvarado et al., 2006). Both the recovery effect, and its attenuation were robust. Together, these two observations are unlikely to be solely the product of the sample's characteristics. Nevertheless, given the nature of our participants, and our sample size, it is with caution that we hypothesize salutary effects for different populations.

We acknowledge that there are additional limitations to the current study. For instance, we argue that mindfulness is generally beneficial and demonstrate that it reduces recovery from retroactive interference. The inference one can draw is that recovery is a negative outcome and not adaptive. However, given sampling characteristics, and the fact that an initial experience is likely to be representative and more frequently occurring, recovery of first learned information is quite adaptive and positive. Reducing recovery is beneficial only when what is first learned is maladaptive and detracts from wellbeing. Viewed from this perspective, the effects of mindfulness on learning may be positive in the context of therapy, but negative in a different context. This seems counterintuitive (as only salutary effects of mindfulness have been reported in the literature) but deserves further investigation.

Finally, the current study only addresses recovery of first learned information within a limited time frame. Future research on whether a focused attention intervention can prevent recovery of first learned information after a longer delay (e.g., days) is merited.

The positive effects of mindfulness-based interventions (e.g. focused attention through mindful breathing) have been well documented (Keng, et al., 2011). Though our study does not elucidate the entire means through which focused attention works, it does demonstrate how it affects spontaneous recovery. This demonstration has theoretical value as it provides future direction for clinical research.

Disclosure Statement

The authors declare no conflict of interest.

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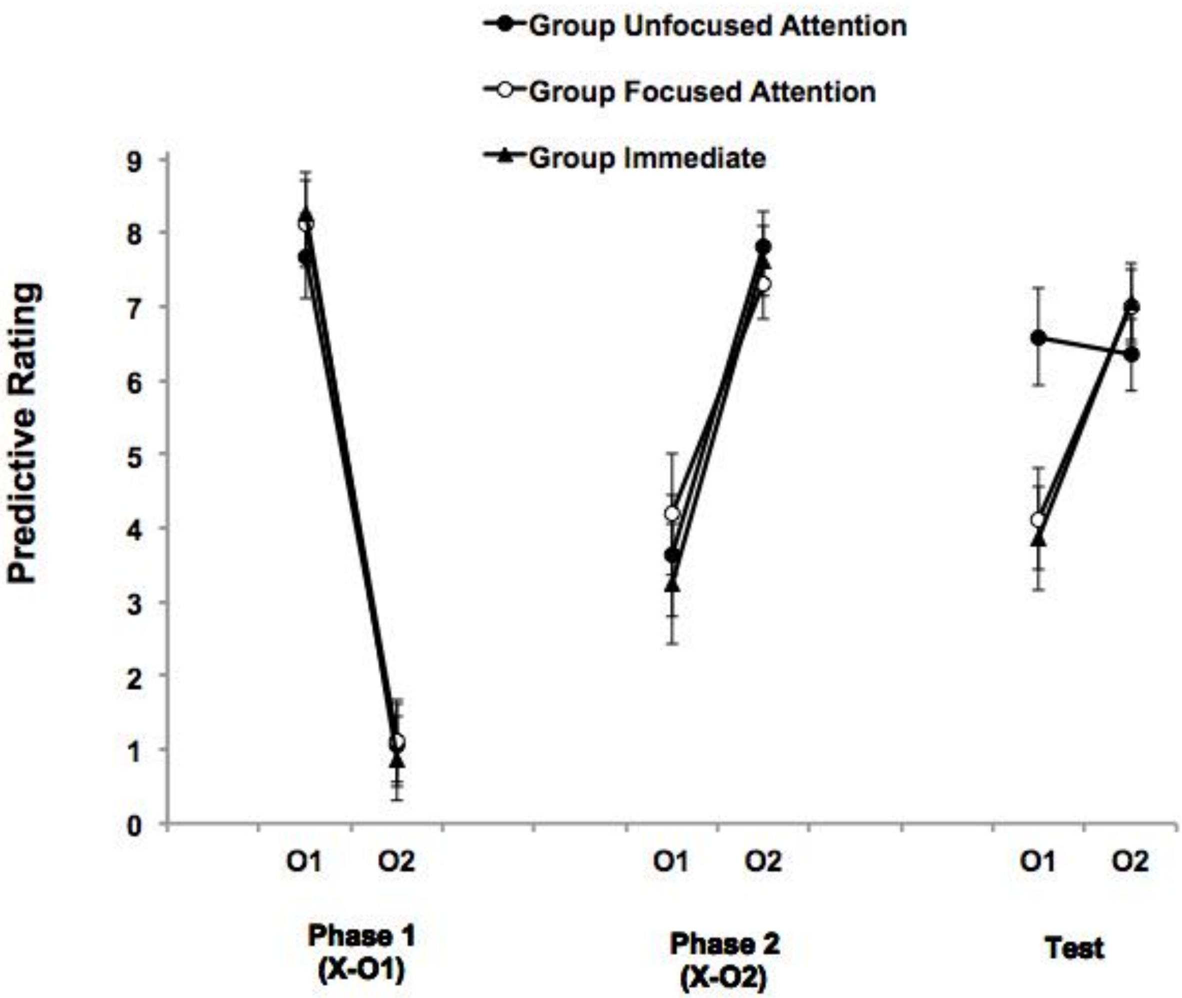

Figure 1. Predictive ratings for O1 and O2 from Phase 1 where X was paired with O1 and Phase 2 where X was paired with O2 and the test. Bars on the points represent the standard error of the mean.

Appendix 1

Focused Attention Induction

Much of the emotional distress people experience is the result of thinking about upsetting things that have already happened or anticipating negative events that have yet to occur.

Distressing emotions such as anger, anxiety, guilt and sadness are much easier to bear if you only focus on the present – one moment at a time.

This is an exercise to increase your mindfulness of the present moment so that you can clear away any thoughts about past and future events.

Start by focusing on your breathing.

Don’t try to change anything about your breathing, just notice the air moving in and out of your body.

Try to focus all of your attention on your breathing.

Notice the sensation of breathing air in. Notice the sensation of breathing air out.

As you breath air into your body, fill your mind with the thought “just this one breath”.

As you breathe air out of your body, fill your mind with the thought “just this one exhale”.

Focus on the actual sensation of breath entering and leaving your body.

Just this one breath in.

Just this one exhale out.

If you notice that your awareness is no longer on your breath, gently bring your awareness back.

Just this one breath.

Just this one exhale.

Continue focusing only on each breath in and each breath out, do not anticipate anything – even your next breath.

Only focus on one breath at a time.

If anything else pops into your mind, push it aside and refocus your attention to each breath.

Continue focusing on each breath in and each exhale out until you hear the sound of the bell.

Appendix 2

Unfocused Attention induction

Much of the emotional distress people experience is the result of thinking about upsetting things that have already happened or anticipating negative events that have yet to occur.

Distressing emotions such as anger, anxiety, guilt and sadness are often brought to mind.

With this exercise let your mind wander freely amongst thoughts about past and future events.

Start by allowing your mind to roam.

Don’t try to focus on your thoughts, just let them drift without hesitation.

There is no need to focus on anything in particular.

Allow yourself to think freely.

Try not to focus on any one thing.

Just let your mind wander.

Openly let your thoughts flow.

Continue to let yourself think freely.

There is no need to think of anything in particular.

Just let your mind wander.

Think about whatever comes to mind.